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A Novel approach on vehicular Ad hoc networks using swarm intelligence approach

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Abstract: Vehicular Ad-hoc networks are type of Mobile ad-hoc networks. In MANETs the vehicles moves in roads and their velocity depends on the road traffic and some restrictions that affected the network. The main aim of VANETs is to maintain the communication between vehicles so the data can be sent efficiently move from one node to another. Various types of Routing protocols are used for efficient routing of data from one place to another. One another technique is used for routing is Swarm intelligence. In this paper various swarm intelligence protocols are defined that should be used for efficient routing and produces better results. All protocols are compared and best routing protocols is chosen so the efficient results should be produced.

Keywords: MANET, VANET, Vanet routing protocols, SI & their routing protocols.

I. INTRODUCTION

MANET stands for Mobile Ad Hoc Network. Mobile means a node that can move in any direction, ad-hoc means one that is continuously used for a specific purpose. A MANET requires no infrastructure and can exist anywhere a node can build its own network. A MANET can be classified as a network with no physical connections. Various areas where MANETS finds applications include military, collaboration, computing, distributed computing, emergency operations, and hybrid architectures. Node efficiency is calculated by a matrix of node lifetime, energy capacity, transmission power, etc. Ad-hoc mobile networks use multipath algorithms to find paths between a source and destination rather than finding a single path between them [1].

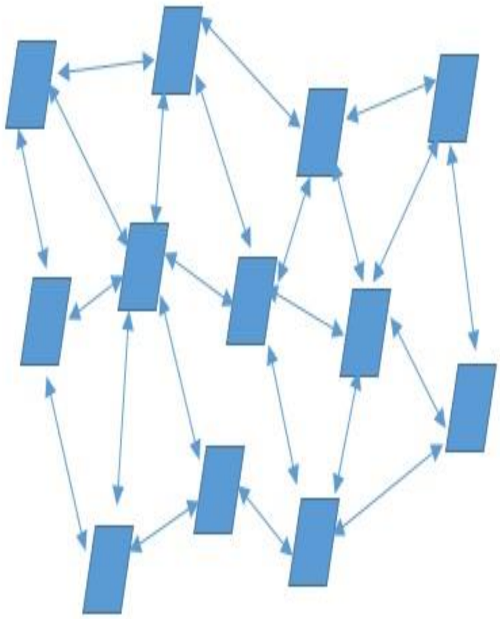

Figure1. Mobile Ad hoc Network

MANET offers various features such as: Ease of access to remote locations, establishment of connectivity when a request is accessed, ability to resize the network as needed, ability to add and remove any number of nodes as needed, thus a symmetrical environment And any infrastructure is susceptible to natural disasters that can destroy them completely.

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So, in order to save infrastructure capital, mobile ad-hoc networks are very useful in conferences and other places where there is no network and people need to share files. Mobile Ad-Hoc Networks Deliver Great Benefits number of technological fields to providing its services. This can be done using the MANET type depending on your site's needs. Particular applications of ad-hoc networks include industrial and commercial applications involving cooperative mobile data exchange. There are many existing and future military network requirements for robust IP-compliant data services within mobile wireless communications networks. Many of these networks consist of highly dynamic autonomous topology segments. The advanced capabilities of mobile ad-hoc networks, such as data rates compatible with multimedia applications, global roaming capabilities, and coordination with other network structures, enable new applications.

The vehicular area network is a growing and very useful application of the network specifically for providing emergency services and other information. This is equally effective in urban and rural settings. A vehicle ad hoc network (VANET) is a special type of mobile ad hoc network (MANET). In 2001, VANET was first described and implemented as part of a "special mobile communication and networking between cars" application where networks could be established and information could be transferred.

Remote VANET is designed to promote contact between vehicular to vehicular (V2V) and roadside to vehicles [2]. Intelligent vehicle-to-vehicle communication and seamless Internet access by incorporating next-generation wireless networking capabilities into vehicles is a promising new technology. VANET nodes are related to each other as servers or clients through mutual radio communication to exchange and transmit information. High node mobility and unreliable channel conditions, which pose challenges of frequent changes in network topology, are specific features of VANET [2] [3].

Therefore, defining and managing routes is a very difficult task for VANETS. Not only does VANET experience rapid changes in wireless backhaul connectivity, but it may also have to deal with a variety of network topologies, unlike traditional ad hoc wireless networks. For example, during rush hour, highways VANETs are more likely to form a very dense network, while VANETs will frequently experience network fragmentation on sparsely populated rural highways or late at night. The high and limited mobility of nodes, radio range arrangements, and variations in node density make routing in VANET a difficult task [35] [36]. High node mobility and unreliable channel conditions, which pose challenges of frequent changes in network topology, are specific features of VANET [3]. Some features of VANET are given below:

i) Frequent trips, limited by both road structure and traffic rules.
ii) The media has enough power, computing power, and storage capacity.
iii) Vehicles are generally aware of their location and spatial environment.

In VANET, routing protocols are divided into five categories which are Topology Based Routing Protocol, Location Based Routing Protocol, Cluster Based Routing Protocol, Geo Routing Protocol and Broadcast routing protocol.[6] These protocols are characterized based on the domain/application to which they are most appropriate [4][5].

II. SWARM INTELLIGENCE (SI)

methods are used in the routing process due to the similarity in swarm and routing behavior. These techniques are used to achieve optimized solutions that provide flexibility and robustness in a cost-effective manner [10]. Examples of swarm intelligence in natural systems include ant colonies, bees, bird flight, hawk hunting, herding, bacterial growth, fish schools, and microbial intelligence object. SI algorithms are a biologically inspired optimization approach that have fast developed in recent years and has been successfully applied to various real-world applications [11] [13]. The most significant advantages of using SI optimization methods are not only that they are flexible and adaptable to problems, but also that they have strong global search capabilities and robust performance [18]. SI mainly uses various types of algorithms These algorithms include Genetic Algorithms (GA), Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Differential Evolution (DE), Artificial Bee Colony (ABC), Glowworm Swarm Optimization (GSO), and Cuckoo Search Algorithm (CSA)[22].

A. Ant colony optimization (ACO) is a population-based meta-heuristic that can be used to find approximate solutions to difficult optimization problems. In ACO, a set of software agents called artificial ants search for good solutions to a given optimization problem. Ant colony optimization is a probabilistic technique for finding optimal paths. Ant colony optimization algorithm is used for solving different computational problems [12]. It is basically dependent on how the ants search the food source even though they are blind and carry the food to their nest [31].

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The deposition of the chemical substance called as pheromone by the ants on the path they travel and the evaporation of this pheromone over certain duration of time, these are the two most essential terms in Ant colony optimization [13]. With the help of pheromone, ants decide which path to follow; this process is the stigmergic communication. As shown in figure, initially all ants move in an unplanned manner to discover the food. When they find food, they carry the food and come to the colony in reverse path by depositing pheromone along the traveled path [26] [14].

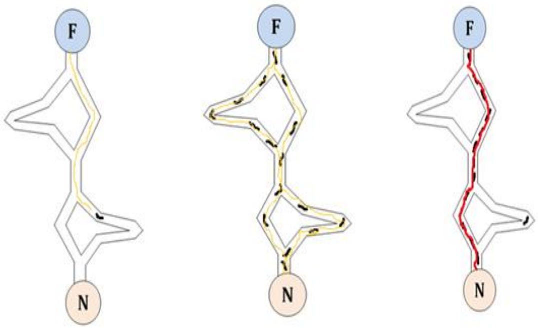

Figure 2. Ant Colony Optimization

Now the nest ants which are coming out from the nest will first check for the amount of pheromone on all the available paths and it will choose the path on which the pheromone concentration is highest. As the time passes more ants will travel on the particular path, which is the shortest path having highest amount of phenomenon [24] [30]. ACO can be used to identify the best solution to various challenges. Few examples are below:

i) Travelling salesman problem
ii) Permutation flow of control
iii) Group shop scheduling problem
iv) Frequency assignment challenge
v) Redundancy allocation problem
vi) Problem with vehicle routing problem

B. Particle swarm optimization (PSO) is a stochastic optimization technique based on the movement and intelligence of swarms. In PSO, the concept of social interaction is used for solving a problem [15]. PSO uses two values Pbest and Gbest. It uses a number of particles (agents) that constitute a swarm moving around in the search space, looking for the best solution. Each particle in the swarm looks for its positional coordinates in the solution space, which are associated with the best solution that has been achieved so far by that particle[19] .It is known as best or personal best. Another best value known as best or global best is tracked by the PSO. This is the best possible value obtained so far by any particle in the neighborhood of that particle.

Flowchart of PSO shows that each particle in swarm optimization has an associated position, velocity, and fitness value. Each particle tracks Particle_bestFitness_value Particle_bestFitness_position. Records are kept for global_bestFitness_position and global_bestFitness_value. [22].Same as in local version it finds its own optimal position pbest, particle does not track the swarm postion. PSO is a probabilistic parallel optimization algorithm. It doesn't need optimized derivatives and continuous functions. Its convergence speed is fast.

The algorithm is simple and easily implemented by programming. One is a property of the optimized function and the other is that various particles die out quickly leading to premature convergence. These two factors are usually closely related. The PSO algorithm fails to produce satisfactory results due to the lack of coordination between good search methods. The reason is that the PSO algorithm does not make full use of the information obtained in the computation process [29].

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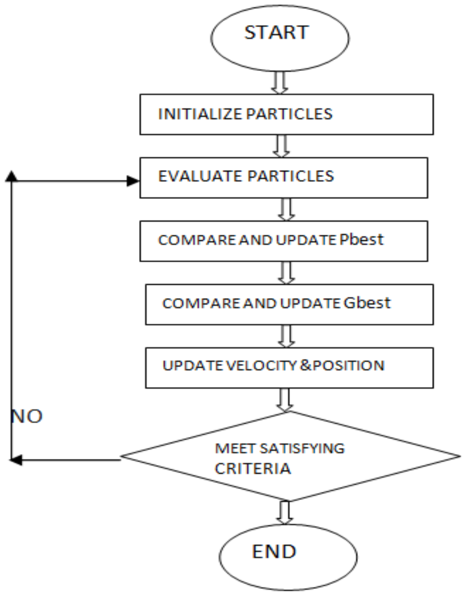

Figure 3. Particle Swarm Optimization

C. Genetic Algorithms (GA) It is a search optimization algorithm based on natural process where each member of population are ranked according to their solutions and new population is formed using particular genetic operator like crossover, reproduction and mutation, fitness evaluation point [20]. Each population is showed as a set of string. GA is applied on variety of optimization problems in which the objective function is discontinuous, non differentiable, stochastic or highly nonlinear algorithms [17]. This flow chart outlines the main algorithmic steps how the Genetic Algorithm Works [22].

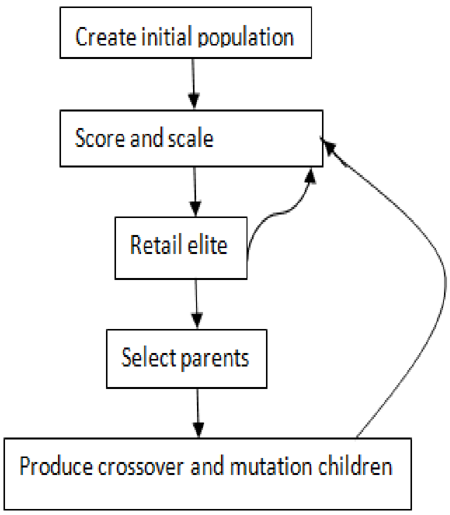

Figure 4. Genetic algorithm

D. Differential Evolution (DE) Differential Evolution (DE) is a population-based synthetic search algorithm that optimizes a problem by iteratively improving a candidate solution based on an evolutionary process. Such algorithms make little or no assumptions about the underlying optimization problem and can quickly explore very large design spaces. The main advantage of the DE standard is that it has only three control parameters that need to be adjusted. The performance of DE in a particular optimization problem depends largely on both the test vector generation scheme and the choice of control parameters.

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DE is the most reliable algorithm, exhibiting robustness, excellent performance, and scalability. In the present study, we investigate the performance of five popular DE variants in dealing with constrained structural optimization problems [22]. More specific the following five problems are considered:

i) Standard differential evolution (DE)
ii) Synthetic differential evolution (CODE)
iii) Differential evolution of self-adaptive control parameters (JDE)
iv) Repository adaptive differential evolution optional external (JADE)
v) Adaptive Differential Evolution (SADE)

E. Artificial Bee Colony (ABC) ABC algorithm is a population-based optimization method that evaluates fitness, therefore the population of candidate solutions is predicted to gravitate toward the search space's better fitness areas. Through natural motivation, population-based optimisation algorithms find near-optimal solutions to challenging optimization problems. Swarm-based optimization algorithms use collaborative trial and error approaches to identify solutions. The ABC optimization algorithms are driven by the peer-to-peer learning behavior of social colonies [22]. ABC consists of a population of potential solutions and finds the optimal solution with an iterative process. The ABC algorithm is divided into four phases: the initialization phase, the employed bees phase, the scout and the onlooker bees phase. ABC algorithm defines simplicity, flexibility, robustness, ability to explore solutions, ease of implementation and capability to handle complex functions.

F. Glowworm Swarm Optimization (GSO) In GSO, swarms of fireflies are randomly placed in the solution space. Each firefly represents a solution of the objective function in the search space and has a certain amount of fireflies. The level of luciferin is related to the suitability of the agent's current position. A lighter individual means a better position (better solution). Using a stochastic mechanism, each agent can only be attracted to a neighbor with higher luciferin intensity than itself within the local decision domain, and move toward that neighbor. The density of a firefly's neighborhood affects its decision radius and determines the size of the local decision region [21]. If the neighborhood density is low, the local decision region is increased to find more neighbors. Otherwise, the herd is reduced so that it can be split into smaller groups. The above process is repeated until the algorithm meets the termination criteria. At this point, most people gather around bright fireflies. Briefly, GSO includes five main phases:-luciferin update phase, neighbor selection phase, motion probability calculation phase, motion phase, and decision radius update phase [22].

G. Cuckoo Search Algorithm (CSA) The cuckoo optimization algorithm is based on the life cycle of the cuckoo bird species. Cuckoos lay their eggs in other birds' nests. The eggs that the cuckoo lays in its host's nest may or may not survive if the host bird identifies an alien cuckoo egg. The host can eject this egg from the nest or leave the nest entirely and build a new nest. To avoid this, the cuckoo mimics the colors, sizes, etc. of the host's eggs and lays eggs very carefully in the host's nest so that the host does not recognize the eggs laid by the cuckoo. This aggressive regeneration strategy has inspired the CS algorithm [22]. So the main point to note here is that the cuckoo needs to be very precise to mimic the host's eggs, and the host needs to be vigilant enough to discern the parasite eggs about it. This is a struggle for survival. We can very meaningfully compare this system to an optimization problem. The egg in the nest represents the solution and the cuckoo's egg represents the new solution [24]. The aim here is to replace the average/not-so-good solution with a better solution. CSA is based on three simple rules or assumptions. Each cuckoo lays only one egg and throws it into a randomly chosen nest. The best nests with good egg quality are passed on to the next generation of cuckoos. Since the host has a fixed number of nests, the probability that the host will identify the cuckoo's egg. So, as already mentioned, the host can either discard the cuckoo's eggs or simply leave the nest and build a new one.

H. Weightless Swarm Algorithm (WSA) Weightless Swarm Algorithm has the same form as the canonical PSO [19]. Several parameters are excluded in particle swarm optimization. The weightless swarm algorithm is used as parameter prominent that work effectively via swapping strategic found from countless trails and errors.WSA is much faster than other algorithms [23]. This algorithm reduces complexity of an algorithm this may lead to reduce in computational cost. WSA gives better results as compared with other algorithms because of simpler code and better memory utilization [23].It updates of *Pbest* and *Gbest*, P defines the best position of particles and G defines the best solution. However, in WSA, instead of doing replacement, swapping of values is adopted.

To improve the convergence of the PSO algorithm without the inertia weight, a third term was added to the velocity update equation as follows

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